

CHAPTER 4 BUILDING DESIGN BY SYSTEMS ANALYSIS

SECTION 401 — SCOPE

401.1 General: This chapter establishes design criteria in terms of total energy use by a building, including all of its systems. Analysis of design for all Group R Occupancies shall comply with Section 402.1 through 402.6.

SECTION 402 — SYSTEMS ANALYSIS

402.1 Special Requirements for All Group R Occupancies

402.1.1 Energy Budgets: Proposed buildings designed in accordance with this section shall be designed to use no more energy from non-renewable sources for space heating and domestic hot water heating than a standard building whose enclosure elements and energy consuming systems are designed in accordance with Section 502.2 of this Code for the appropriate climate zone and heating system type. Energy derived from renewable sources may be excluded from the total annual energy consumption attributed to the alternative building.

402.1.2 Calculation of Energy Consumption: The application for a building permit shall include documentation which demonstrates, using a calculation procedure as listed in Chapter 8, or an approved alternate, that the proposed building's annual space heating energy use does not exceed the annual space heating and water heating energy use of a standard building conforming to Chapter 5 of this Code for the appropriate climate zone. The total calculated annual energy consumption shall be shown in units of kWh/ft²-year or Btu/ft²-year of conditioned area.

402.1.3 Input Values: The following standardized input values shall be used in calculating annual space heating budgets:

<u>Parameter</u>	<u>Value</u>
Thermostat	
Thermostat set point, heating	65°F
Thermostat set point, cooling	78°F
Thermostat night set back	65°F
Thermostat night set back period	0 hours
Internal Gain	
R-3 and R-4 units	3000 Btu/h
R-1 and R-2 units	1500 Btu/h
Domestic Hot Water Heater Setpoint	120°F
Domestic Hot Water Consumption	20 gallons per person per day

Parameter

Minimum Heat Storage

Value

Calculated using standard engineering practice for the actual building or as approved.

Site Weather Data

Typical meteorological year (TMY) or ersatz TMY data for the closest appropriate TMY site or other sites as approved.

Heating Equipment Efficiency

Equipment shall comply with Section 1411

The standard building shall be modeled with glazing area distributed equally among the four cardinal directions. Parameter values that may be varied by the building designer to model energy saving options include, but are not limited to, the following:

1. Overall thermal transmittance, U_o , of building envelope or individual building components.
2. Heat storage capacity of building.
3. Glazing orientation; area; and solar heat gain coefficients.
4. Heating system efficiency.

402.1.4 Solar Shading and Access: Building designs using passive solar features with 8% or more south facing equivalent glazing to qualify shall provide to the building official a sun chart or other approved documentation depicting actual site shading for use in calculating compliance under this section. The building shall contain at least 45 Btu/°F for each square foot of south facing glass.

402.1.5 Infiltration: Infiltration levels used shall be set at 0.35 air changes per hour for thermal calculation purposes only.

402.1.6 Heat Pumps: The heating season performance factor (HSPF) for heat pumps shall be calculated using procedures consistent with Section 5.2 of the U.S. Department of Energy "Test Procedure for Central Air Conditioners, Including Heat Pumps," published in the December 27, 1979, Federal Register, Vol. 44, No. 24, 10 CFR 430. Climate data as specified above, the

proposed buildings overall thermal performance value (Btu/°F) and the standardized input assumptions specified above shall be used to model the heat pump's HSPF.

402.2 Energy Analysis: Compliance with this chapter will require an analysis of the annual energy usage, hereinafter called an annual energy analysis.

EXCEPTION: Chapters 5 and 6 of this Code establish criteria for different energy-consuming and enclosure elements of the building which will eliminate the requirement for an annual systems energy analysis while meeting the intent of this Code.

A building designed in accordance with this chapter will be deemed as complying with this Code if the calculated annual energy consumption is not greater than a similar building (defined as a "standard design") whose enclosure elements and energy-consuming systems are designed in accordance with Chapter 5.

For an alternate building design to be considered similar to a "standard design," it shall utilize the same energy source(s) for the same functions and have equal floor area and the same ratio of envelope area to floor area, environmental requirements, occupancy, climate data and usage operational schedule.

402.3 Design: The standard design, conforming to the criteria of Chapter 5 and the proposed alternative design shall be designed on a common basis as specified herein.

The comparison shall be expressed as kBtu or kWh input per square foot of conditioned floor area per year at the building site.

402.4 Analysis Procedure: The analysis of the annual energy usage of the standard and the proposed alternative building and system design shall meet the following criteria:

- a. The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be detailed to permit the evaluation of effect of factors specified in Section 402.5.
- b. The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be detailed to permit the evaluation of the effect of system design, climatic factors, operational characteristics and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of systems and equipment. The calculation procedure shall be based upon 8,760 hours of operation of the building and its service systems.

402.5 Calculation Procedure: The calculation procedure shall cover the following items:

- a. Design requirements--Environmental requirements as required in Chapter 3.
- b. Climatic data--Coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.
- c. Building data--Orientation, size, shape, mass, air, moisture and heat transfer characteristics.
- d. Operational characteristics--Temperature, humidity, ventilation, illumination, control mode for occupied and unoccupied hours.
- e. Mechanical equipment--Design capacity, part load profile.
- f. Building loads--Internal heat generation, lighting, equipment, number of people during occupied and unoccupied periods.

EXCEPTION: Group R Occupancy shall comply with the calculation procedures in Chapter 8, or an approved alternate.

402.6 Documentation: Proposed alternative designs, submitted as requests for exception to the standard design criteria, shall be accompanied by an energy analysis comparison report. The report shall provide technical detail on the two building and system designs and on the data used in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of Chapter 4 of this Code.

4. Zones where specific humidity levels are required to satisfy process needs, such as computer rooms, museums, surgical suites, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses and ice arenas.

1436 Heat Recovery: Fan systems which have both a capacity of 5,000 cfm or greater and which have a minimum outside air supply of 70% or greater of the total air circulation shall have a heat recovery system with at least 50% recovery effectiveness. Fifty percent heat recovery effectiveness shall mean an increase in the outside air supply temperature at design heating conditions of one half the difference between the outdoor design air temperature and 65°F. Provisions shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1433. Heat recovery energy may be provided from any site-recovered or site-solar source.

EXCEPTIONS: 1. Laboratory systems equipped with both variable air volume supply and variable air volume or two-speed exhaust fume hoods.

2. Systems serving spaces heated to less than 60°F.

3. Systems which can be shown to use as much energy with the addition of heat recovery equipment as without it.

4. Systems exhausting toxic, flammable, paint exhaust or corrosive fumes making the installation of heat recovery equipment impractical.

5. Type I commercial kitchen hoods.

1437 Electric Motor Efficiency: Design A & B squirrel-cage. T-frame induction permanently wired polyphase motors of 1 hp or more having synchronous speeds of 3,600, 1,800 and 1,200 rpm shall have a nominal full-load motor efficiency no less than the corresponding values for energy efficient motors provided in Table 14-4.

EXCEPTIONS: 1. Motors used in systems designed to use more than one speed of a multi-speed motor.

2. Motors used as a component of the equipment meeting the minimum equipment efficiency requirements of Section 1411 and Tables 14-1A through 14-1G provided that the motor input is included when determining the equipment efficiency.

3. Motors that are an integral part of specialized process equipment.

4. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.

1438 Variable Flow Systems: For fans and pumps greater than 10 hp, where the application involves variable flow, there shall be variable speed drives or variable flow devices installed. Acceptable variable flow devices include variable inlet vanes, variable blade pitch and variable fan geometry. Throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.

1439 Exhaust Hoods

1439.1 Kitchen Hoods. Individual kitchen exhaust hoods larger than 5000 cfm shall be provided with make-up air sized so that at least 50% of exhaust air volume be (a) unheated or heated to no more than 60°F and (b) uncooled or cooled without the use of mechanical cooling.

EXCEPTIONS: 1. Where hoods are used to exhaust ventilation air which would otherwise exfiltrate or be exhausted by other fan systems.

2. Certified grease extractor hoods that require a face velocity no greater than 60 fpm.

1439.2 Fume Hoods: Each fume hood in buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm shall include at least one of the following features:

a. Variable air volume hood exhaust and room supply systems capable of reducing exhaust and make-up air volume to 50% or less of design values.

b. Direct make-up (auxiliary) air supply equal to at least 75% of the exhaust rate, heated no warmer than 2°F below room set point, cooled to no cooler than 3°F above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control.

c. Heat recovery systems to precondition make-up air in accordance with Section 1436, without using any exception.

d. Constant volume fume hood designed and installed to operate at less than 50 fpm face velocity.

SECTION 1440 — SERVICE WATER HEATING

1441 Water Heater Installation: Electric water heaters in unconditioned spaces or on concrete floors shall be placed on an incompressible, insulated surface with a minimum thermal resistance of R-10.

1442 Shut-Off Controls: Systems designed to maintain usage temperatures in hot water pipes, such as circulating hot water systems or heat traced pipes shall be equipped with automatic time switches or other controls to turn off the system during periods of non-use.

1443 Pipe Insulation: Piping shall be thermally insulated in accordance with Section 1415.1.

SECTION 1450 — HEATED POOLS

1451 General: The requirements in this section apply to “general and limited use pools” as defined in the Washington Water Recreation Facilities Regulations (WAC 246-260).

1452 Pool Water Heaters: Heat pump pool heaters shall have a minimum COP of 4.0 determined in accordance with ASHRAE Standard 146, Method of Testing for Rating Pool Heaters. Other pool heating equipment shall comply with the applicable efficiencies in Tables 141A through 14-1G.

1453 Controls: All pool heaters shall be equipped with a readily accessible ON/OFF switch to allow shutting off the operation of the heater without adjusting the thermostat setting. Controls shall be provided to allow the water temperature to be regulated from the maximum design temperature down to 65°F.

1454 Pool Covers: Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90°F shall have a pool cover with a minimum insulation value of R-12.

TABLE 14-1A
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED,
MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency ^b	Test Procedure ^a
Air Conditioners, Air Cooled	< 65,000 Btu/h	Split System	10.0 SEER	ARI 210/240
		On or After Jan 23, 2006 ^d	13.0 SEER	
		Single Package	9.7 SEER	
		On or After Jan 23, 2006 ^d	13.0 SEER	
	≥65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.3 EER ^c 10.6 IPLV ^c	ARI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	9.7 EER ^c 9.9 IPLV ^c	
	≥ 240,000 Btu/h and <760,000 Btu/h	Split System and Single Package	9.5 EER ^c 9.7 IPLV ^c	
	≥760,000 Btu/h	Split System and Single Package	9.2 EER ^c 9.4 IPLV ^c	
Through-the-Wall, Air Cooled	<30,000 Btu/h	Split System	10.0 SEER	ARI 210/240
		On or After Jan 23, 2006	10.9 SEER	
		Single Package	9.7 SEER	
		On or After Jan 23, 2006 ^d	10.6 SEER	
Air Conditioners, Water and Evaporatively Cooled	< 65,000 Btu/h	Split System and Single Package	12.1 EER 11.2 IPLV	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	11.5 EER ^c 10.6 IPLV ^c	
	≥135,000 Btu/h and ≤240,000 Btu/h	Split System and Single Package	11.0 EER ^c 10.3 IPLV ^c	ARI 340/360
	> 240,000 Btu/h	Split System and Single Package	11.0 EER ^c 10.3 IPLV ^c	
Condensing Units, Air Cooled	≥135,000 Btu/h		10.1 EER 11.2 IPLV	ARI 365
Condensing Units, Water or Evaporatively Cooled	≥135,000 Btu/h		13.1 EER 13.1 IPLV	

^a Reserved.

^b IPLVs are only applicable to equipment with capacity modulation.

^c Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

^d Date of manufacture for single-phase air-cooled air-conditioners < 65,000 Btu/h, as regulated by NAECA. SEER values are those set by NAECA.

TABLE 14-1B
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED,
MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency ^b	Test Procedure ^a
Air Cooled, (Cooling Mode)	< 65,000 Btu/h	Split System	10.0 SEER	ARI 210/240
		On or After Jan 23, 2006 ^d	13.0 SEER	
		Single Package	9.7 SEER	
	≥65,000 Btu/h and < 135,000 Btu/h	On or After Jan 23, 2006 ^d	13.0 SEER	ARI 340/360
		Split System and Single Package	10.1 EER ^c 10.4 IPLV ^c	
		Split System and Single Package	9.3 EER ^c 9.5 IPLV ^c	
Through-the-Wall (Air Cooled, Cooling Mode)	<30,000 Btu/h	Split System	10.0 SEER	ARI 210/240
		On or After Jan 23, 2006 ^d	10.9 SEER	
		Single Package	9.7 SEER	
		On or After Jan 23, 2006 ^d	10.6 SEER	
Water-Source (Cooling Mode)	< 17,000 Btu/h	86°F Entering Water	11.2 EER	ARI/ISO-13256-1
	≥ 17,000 Btu/h and <65,000 Btu/h	86°F Entering Water	12.0 EER	ARI/ISO-13256-1
	≥65,000 Btu/h and < 135,000 Btu/h	86°F Entering Water	12.0 EER	ARI/ISO-13256-1
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	59°F Entering Water	16.2 EER	ARI/ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	77°F Entering Water	13.4 EER	ARI/ISO-13256-1
Air Cooled (Heating Mode)	< 65,000 Btu/h ^d (Cooling Capacity)	Split System	6.8 HSPF	ARI 210/240
		On or After Jan 23, 2006 ^d	7.7 HSPF	
		Single Package	6.6 HSPF	
		On or After Jan 23, 2006 ^d	7.7 HSPF	
	≥65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP	ARI 340/360
		17°F db/15°F wb Outdoor Air	2.2 COP	
	≥135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.1 COP	ARI 340/360
		17°F db/15°F wb Outdoor Air	2.0 COP	

TABLE 14-1B (CONTINUED)
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED,
MINIMUM EFFICIENCY REQUIREMENTS

Through-the-Wall (Air Cooled, Heating Mode)	<30,000 Btu/h ^d	Split System	6.8 HSPF	ARI 210/240
		On or After Jan 23, 2006 ^d	7.1 HSPF	
		Single Package	6.6 HSPF	
		On or After Jan 23, 2006 ^d	7.0 HSPF	
Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	68°F Entering Water	4.2 COP	ARI/ISO-13256-1
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	50°F Entering Water	3.6 COP	ARI/ISO-13256-1
Ground Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	32°F Entering Water	3.1 COP	ARI/ISO-13256-1
^a Reserved. ^b IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation. ^c Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat. ^d Date of manufacture for single-phase air-cooled heat pumps < 65,000 Btu/h, as regulated by NAECA. SEER and HSPF values are those set by NAECA				